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Christian Caron
Springer Heidelberg
Physics Editorial Department I
Tiergartenstrasse 17
69121 Heidelberg / Germany
christian.caron@springer.com

Thomas Henning (Ed.)

Astromineralogy

Second Edition

Springer

Thomas Henning
MPI für Astronomie
Königstuhl 17
69117 Heidelberg
Germany
henning@mpia-hd.mpg.de

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Preface

The space between the stars is not empty, but filled with interstellar matter, mostly composed of atomic, ionized or molecular hydrogen, depending on the temperature and density of the various phases of this medium. About 1% of the total mass of interstellar matter in our galaxy is contained in small solid particles, ranging in size from a few nanometers to many microns and even millimeters in planet-forming disks around young stars. This cosmic dust undergoes a complicated life cycle, with fresh material produced in the outflows of evolved stars and supernovae, modified by shocks and cosmic rays in the diffuse interstellar medium and providing the surface for the formation of molecular ices in cold and relatively dense molecular clouds.

Although elemental abundances, formation routes, extinction curves, and early infrared and ultraviolet spectroscopy pointed to the presence of silicates, carbides, and graphitic material in space, it was only recently that a new field – astromineralogy – emerged from astronomical observations. The unprecedented spectral resolution and wavelength coverage provided by the *Infrared Space Observatory* together with dedicated experimental work in the field of laboratory astrophysics provided the unambiguous identification of minerals in space, ranging from olivines and pyroxenes to various carbides.

Cosmic mineralogy already provided earlier results on minerals in space by the in-situ study of minerals which entered the solar system. Meanwhile, we see a bridge between astronomically identified minerals and stardust minerals found by their isotopic signatures in meteorites and interplanetary dust. This may lead to a wider definition of astromineralogy that includes these investigations. A comprehensive study in this field should certainly include the comparative investigation of cometary dust material.

First seminars on astromineralogy were held at the University of Amsterdam and the University of Heidelberg. They showed the large interest of astronomers, physicists, chemists, and mineralogists in this new field and encouraged the publication of the first edition of this book in 2003. Meanwhile, a flood of new dust data arrived from the *Spitzer Infrared Space Telescope* which provided unprecedented sensitivity in the field of astronomical infrared spectroscopy. In addition, the *Stardust Mission* returned material from the comet 81P/Wild 2 to Earth for in-situ analysis. These new data together with progress in ground-based observations and laboratory astrophysics led to the idea for a second revised edition of this book.

The publication of this second edition comes at a time where the cryogenic part of the *Spitzer* mission just came to its end. With the launch of the *Herschel Observatory* during the final editing of this book, a new era of the exploration of the cold dusty universe just started. On the horizon is the *James Webb Space Telescope* which will allow to extend astromineralogy to even fainter objects and will provide information on the spatial distribution of minerals in protoplanetary disks and other environments. In a planning stage, there are other missions to bring back interstellar grains to Earth for their in-situ analysis.

I would like to thank all authors for their contributions to this book and their willingness to revise their chapters and to follow my recommendations. In addition, I thank my former colleagues Drs. J. Dorschner, J. Gürtler, C. Jäger and H. Mutschke for many years of fruitful collaboration in the experimental characterization of cosmic dust analogues in our Jena dust group, which paved the way for the identification of minerals in space. This work is now continued in the laboratory astrophysics facility of the Max Planck Institute for Astronomy at the University of Jena under the leadership of Drs. F. Huisken and C. Jäger.

Finally, I would like to thank J. Weiprecht and C. Schnupp. Without their technical help, the production of this book would not have been possible.

Heidelberg, Germany Thomas Henning
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